accords with the evolution of the animal kingdom in its different stages, that there must be a period in both instances where the phenomena of *life* are independent of any brain or nervous system such as we understand it.

Again, there is a *variety or individuality* in this "blind instinct" which must exist *before* the chemical and physical influences are brought to bear upon the original "particle of protoplasm," whose particular development is by this particular instinct insured; for no two individuals are exactly alike, to say nothing of specific differences; while the subsequent existence of this "particular instinct," after the development has fulfilled all that is required of it, may be inferred, just as the leaves in autumn, after having fallen from a deciduous tree, to return to the dust from which they originally came, are succeeded by a similar development the following year under a similar instinct—or as the butterfly, perishing after the act for which all its elaborate metamorphoses have been passed through has been completed, appears again another year under similar circumstances.

EXPLANATION OF PLATE XIV. A.

Fig. 1. *Spirogyra* endeavouring to conjugate with *Cladophora*. *a a*, two cells of *Spirogyra* connected; *b b*, remains of spiral bands or gonimic contents; *c*, septum; *d d*, two bunches of root-like processes, respectively applied to *e*, filament of *Cladophora*.

Fig. 2. The same. *a*, single cell of *Spirogyra*; *b b*, remains of spiral bands or gonimic contents; *c*, bunch of root-like processes applied to *d*, filament of *Cladophora*.

Fig. 3. The same. *a a*, two cells of *Spirogyra* disconnected; *b b b*, remains of spiral bands or gonimic contents; *c c*, bunches of root-like processes applied to *d d*, two connected cells of *Cladophora*; *e e*, gonimic contents; *f*, septum.

XXVII.—*On Fossil Sponge-spicules from the Carboniferous Strata of Ben Bulben, near Sligo.* By H. J. Carter, F.R.S. &c.

[Plate XIV. B. figs. 1–17.]

In the last contribution that Mr. James Thomson made to our knowledge of fossil sponges which existed during the Carboniferous epoch in the neighbourhood of Glasgow ('Annals,' 1879, vol. iii. p. 141, pl. xxi.), I described and illustrated *Holasterella conferta*, a genus of sponges, as the name indicates, exclusively composed of stelliform spicules, whose typical figure, from the same locality, had been found and illustrated a year previously. At the same time I added (*ibid.* p. 145) some observations on specimens of limestone belonging to the Carboniferous series which Mr. Thomson had gathered from the western side of Black Head, county Clare, at the southern extremity of the entrance to Galway Bay, in which the siliceous element (often present in great quantity) seemed to indicate that it had been derived from some organisms more or less composed of silica, especially as in other parts, where the limestone is pure, the remains of sponge-spicules in a calcified state are abundantly recognizable, although in none of the specimens sent to me could I find a *definite* form.

Here the matter rested, so far as I myself was concerned; but Mr. Joseph Wright, F.G.S., who resides at Belfast, having subsequently visited the mountain near Sligo called "Ben Bulben," actually ascertained the presence of several forms of sponge-spicules in the limestone of the Carboniferous system there, and kindly forwarded specimens of them to me, together with fragments of the strata in which they are found, for description and illustration. But before I proceed to this, it is desirable that the following extracts from Mr. Wright's letter, dated Jan. 1, 1880, which accompanied them, should be given, viz.:—

"Last summer my friend Mr. S. A. Stewart spent a few days botanizing on Ben Bulben, and, whilst there, observed soft clay bands in the limestone, of which he brought me three different 'gatherings' to examine for Foraminifera, viz.:—1, containing no organisms; 2, a few Foraminifera and spicules; and 3, rich in sponge-spicules.

"The last material proved so interesting that we afterwards visited the place in company and brought away a quantity of the clay. It is of a pale yellowish colour, and occurs interstratified with bands of chert, especially at the summit of the mountain, where it is very soft, owing, apparently, to exposure to the weather; on the other hand, lower down, the same yellow material occurs, but much harder, although lighter, from its open pumice-like structure. At both places we found a great number of fossils belonging to the limestone of the Carboniferous system, viz. . . . . .

"I sent some of the clay to a friend in Cork for analysis; and he has informed me that it contains 98 per cent. of silica."

After this follow sketches of all the forms of fossil sponge-spicules that Mr. Wright by dexterous manipulation was enabled to extricate from the clay—to which, after carefully looking over all that he found, which were subsequently forwarded to me, I can add no more specifically, although I have been able to find a few with slightly different forms, which have assisted me in the following descriptions. Of course, as drift-spicules, which these must have been when originally deposited, to say nothing of the subsequent effects of fossilization &c., they are nearly all fragmentary; but sufficient of them remains for easy recognition and for restoration, as will be seen by the illustrations.

First and foremost is a sexradiate stellate (Pl. XIV. B. fig. 2), which in number of rays varies from 6, 12, 18 to 24 (figs. 4–7), according to the amount of division of the extremities of six arms. The stellates vary in size from 1-75th to 5-24ths of an inch (fig. 1) in diameter; and the smallest are not only the most numerous and have the greatest number of rays, but, as the latter often arise from a division of the arm close to the centre, they acquire the appearance of globular little stars; while, where the arms are a little more extended, they often present the appearance of a "Maltese cross." But the most striking feature of this spicule is that, from the smallest to the largest, each ray is spiriform; that is, its surface presents a spiral inflation in which the coils are more or less numerous, extending from the base to the apex of the ray (figs. 2 and 3); where they are most numerous they, of course, are more transverse, and then appear like separate annulations; while the most remarkable difference in them is confined to the rays of the largest stellates, where, towards the base, the spiral line of inflation becomes broken up into short portions (fig. 3, *b*), which look very much, from their alternate arrangement in adjoining coils, as if this had been produced by another spiral groove pursuing an opposite direction (that is, across the original inflation).

This fossil spicule is incomparably more numerous than the other spicular forms accompanying it; so that, together with its peculiarities *being confined to a stellate form*, I am compelled to think that it must have belonged to a species of *Holasterella* which, if found *in situ* hereafter (that is, forming the entire sponge), will be like *H. conferta*; hence I have much pleasure in naming it *Holasterella Wrightii*, after its discoverer.

The next spicule in frequency appears to have been a hexactinellid, with the sixth or external arm not produced as in the large surface-spicules of the Sarcohexactinellida, in which four arms are extended over the surface laterally, while the fifth, like the shaft of a nail, goes vertically inwards (fig. 8). With this, and also equally plentiful, are the free ends of "anchoring-spicules" terminated by four much-recurved spines or flukes situated opposite each other, and still attached to a small fragment of the shaft (fig. 9), longer and larger portions of which may be observed in the "chert," both longitudinally and in transverse sections under fracture, indicating that with the anchoring ends they are the fragmentary remains of what originally were anchoring- or cord-spicules of a *Hyalonema* or Sarcohexactinellid sponge.

Tolerably numerous also are Lithistid spicules, especially one like a tripod, in which the centre is convex and smooth, while the three legs, bending outwards and downwards, end respectively in expanded concave feet, which seem to show that they were once applied to similar surfaces on adjoining spicules (figs. 10 and 11). This in all probability was a surface-spicule like those of *Corallistes aculeata* ('Annals,' 1880, vol. vi. pl. vii. fig. 45). Fragments of other Lithistid spicules are also present, such as the dendritically branched surface-spicule (fig. 12), and the shafted one of the fully developed or internal structure (fig. 13).

To these may be added a sausage-shaped spicule like that of some of the *Renieræ* of the present day, also tolerably plentiful (fig. 14); and other fusiform acerate ones (figs. 15 and 16), which being common to many kinds of sponges, cannot in their isolated state be identified with any in particular.

Two fragments represent the arms of a quadriradiate spicule (fig. 17); but whether these were equal in length, or one was prolonged into a shaft, there is no evidence to show: if the former, it probably belonged to one of the Pachastrellina; if the latter, to a zone-spicule of one of the Pachytragida.

The most interesting part of this discovery, however, is that the "clay" of Ben Bulben, in which Mr. Wright found these remains, is apparently identical in every respect with that sent me by Mr. James Thomson, in which he found *Holasterella conferta*, near Glasgow. In both instances isolated sponge-spicules of different kinds are disseminated through it, which can be obtained by edulcoration with water, and are composed of silica in an opaque or chalcedonic state, rendered more or less irregular by the presence of rhomboidal excavations on the surface.

Here I might observe that, not only are the sponge-spicules, and the minute fossils of the Carboniferous Limestone which accompany them, silicified and pitted on the surface with the same kind of rhomboidal excavations, but the "chert" to which Mr. Wright has alluded appears to be a solid pseudomorph of the limestone; for its pumice-like worm-eaten character occurring here and there, from partial absorption or decomposition of the material, presents a skeletal rhomboidal structure; while the same kind of rhomboidal excavations characterize the surface of the weather-worn *calcareous* fossils in the *pure Devonian Limestone* of this neighbourhood; by which I am led to infer that, in the first place, the sponge-spicules become partially or wholly calcified among *calcareous* material, else why should they now present rhomboidal excavations on their surface? that subsequently the siliceous element, being liberated, replaced the calcareous material so as to form the "chert;" and, thirdly, that the rhomboidal excavations on the surface of the spicules and the partial absorption of the spicules themselves, leaving nothing but their moulds, arises from the changes which the siliceous element itself is now undergoing—that is, becoming decomposed and removed, or passing from an amorphous state into clear quartz prisms. The latter, although but slightly the case, comparatively, in the specimens from Ben Bulben, is characteristically so in the specimens to which I have alluded from Black Head, co. Clare, wherein not only geodic cavities lined with quartz prisms, but perfect prisms themselves are present, imbedded in the amorphous siliceous material composing the rock, while all satisfactory traces of sponge-spicule form in these parts is entirely absent, so far as the specimens sent to me indicated.

Lastly, I am inclined to think that the "clay" of Ben Bulben is the "chert" decomposed, and that the innumerable fragments of sponge-spicules which are present in the latter (for in some parts the chert appears to be almost entirely composed of them), rendered still more fragmentary by partial removal so as to leave nothing but their moulds, as before stated, are those which at last come out entire, so far as they go, in the washing of the "clay."

It is remarkable, too, that by far the most plentiful among Mr. Thomson's collection of spicules from the clay near Glasgow is that of *Holasterella conferta*, as it is that of *H. Wrightii* at Ben Bulben; the "sausage-shaped" spicule (fig. 14) is also analogous to that of the supposed Renierid sponge ('Annals,' 1879, vol. iii. pl. xxi. fig. 11), and about the same in frequency. In Mr. Thomson's collection were also fragments of Lithistid spicules; and last summer he sent me a section of an entire sponge in Carboniferous Limestone, all calcified, with weathered-out spicules on the surface, but none of it sufficiently defined for useful delineation. The collection also contained some zone-spicules of the Pachytragida; so that, altogether, the Spongida appear to have been as plentiful and as varied in the Carboniferous age as at any other time.

It would be worth while, when the opportunity offers, for some one to look over the weathered surface of the strata in the mountain of Ben Bulben, where fragments, if not entire specimens, of sponges from which the spicules come might be found, after the manner that they have been discovered in the Carboniferous system in the south-west of Scotland.

EXPLANATION OF PLATE XIV. B.

Fig. 1. *Holasterella Wrightii*, spicule of, nat. size. The largest met with (diagram).
Fig. 2. The same, restored, to show the perfect form with spiral inflation on the arms. Magnified 7 diameters.
Fig. 3. The same. Furcate arm, much more magnified, to show—*a*, the simple spiral inflation, and *b*, the same when "broken up." Scale 1-48th to 1-1800th inch.
Figs. 4, 5, 6, and 7. The same, to show the simple sexradiate and multifid divisions of the arms respectively (diagrams).
Fig. 8. Sarcohexactinellid. Fragment of large surface-spicule of unknown species.
Fig. 9. The same. Free end of anchoring-spicule.
Fig. 10. Lithistid. ? Tripod-like surface-spicule of unknown species.
Fig. 11. The same. Lateral view.
Fig. 12. The same. Dendritically branched surface-spicule of unknown species.
Fig. 13. The same. Form of body-spicule of unknown species.
Fig. 14. *Reniera* ?. Sausage-shaped spicule of unknown species.
Fig. 15. Acerate spicule of unknown sponge.
Fig. 16. The same.
Fig. 17. Quadriradiate fragment of spicule of unknown sponge.

N.B. Figs. 3 and 8–17 inclusively are all drawn to the scale of 1-48th to 1-1800th inch.

XXVIII.—*Descriptions of new Species of Asiatic Lepidoptera Heterocera.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

[Continued from p. 129.]

38. *Thalassodes opalina*, sp. n.

Wings semitransparent, emerald-green, striated all over with white and with opaline reflections: primaries crossed in the middle by a straight transverse slender white line; a shorter and less-defined line towards the apex; costal margin yellow, fringe tipped with yellow: secondaries angulated, a slender angulated white line beyond the middle, sinuated below the angulation; basal half of subcostal vein yellow, fringe tipped with yellow: antennæ white at base, golden